इंटरनेट मानक

Disclosure to Promote the Right To Information

Whereas the Parliament of India has set out to provide a practical regime of right to information for citizens to secure access to information under the control of public authorities, in order to promote transparency and accountability in the working of every public authority, and whereas the attached publication of the Bureau of Indian Standards is of particular interest to the public, particularly disadvantaged communities and those engaged in the pursuit of education and knowledge, the attached public safety standard is made available to promote the timely dissemination of this information in an accurate manner to the public.

“जानने का अधिकार, जीने का अधिकार”
Mazdoor Kisan Shakti Sangathan
“The Right to Information, The Right to Live”

“पुराने को छोड नये के तरफ”
Jawaharlal Nehru
“Step Out From the Old to the New”

IS 12761-3 (1989): Equipment for continuously monitoring radioactivity in gaseous effluents, Part 3: Specific requirements for noble gas effluent monitors [LITD 8: Electronic Measuring Instruments, Systems and Accessories]

“ज्ञान से एक नये भारत का निर्माण”
Satyanarayan Gangaram Pitroda
“Invent a New India Using Knowledge”

Act Number 22 of 2005
The Indian Parliament
RIGHT TO INFORMATION

Made Available By
Public.Resource.Org

“ज्ञान एक ऐसा खजाना है जो कभी चुराया नहीं जा सकता है”
Bhartṛhari—Nītiśatakam
“Knowledge is such a treasure which cannot be stolen”

BLANK PAGE

BRUTUM FULMEN

IGNORANTIA JURIS NON EXCUSAT

PROTECTED BY COPYRIGHT

IS 12761 (Part 3) : 1989
IEC Pub 761-3 (1983)
(Reaffirmed 2006)

Indian Standard

EQUIPMENT FOR CONTINUOUSLY MONITORING RADIOACTIVITY IN GASEOUS EFFLUENTS

PART 3 SPECIFIC REQUIREMENTS FOR NOBLE GAS EFFLUENT MONITORS

भारतीय मानक

गैसीय बहिस्रावों में अपक्रांतिकता लगातार मानीटर करने के लिए भारतीय मानक उपस्कर

भाग 3 उत्कृष्ट गैस बहिस्राव मानीटरों की विशिष्ट अपेक्षाएें

UDC 621·039·76 : 628·512

© BIS 1990

BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

March 1990 **Price Group 8**

IS 12761 (Part 3) : 1989
IEC Pub 761-3 (1983)

Indian Standard

EQUIPMENT FOR CONTINUOUSLY MONITORING RADIOACTIVITY IN GASEOUS EFFLUENTS

PART 3 SPECIFIC REQUIREMENTS FOR NOBLE GAS EFFLUENT MONITORS

NATIONAL FOREWORD

This Indian Standard, which is identical with IEC Pub 761-3 (1983) 'Equipment for continuously monitoring radioactivity in gaseous effluents : Part 3 Specific requirements for noble gas effluent monitors', issued by the International Electrotechnical Commission (IEC), was adopted by the Bureau of Indian Standards on 19 September 1989, on the recommendation of the Nuclear Instrumentation Sectional Committee (LTDC 26) and approval of the Electronics and Telecommunication Division Council.

Wherever the words 'International Standard' appear, referring to this standard, they should be read as 'Indian Standard'.

CROSS REFERENCE

In this Indian Standard, the following International Standard is referred to. Read in its place the following:

International Standard	*Corresponding Indian Standard*	*Degree of Correspondence*
IEC Pub 761-1 (1983) Equipment for continuously monitoring radioactivity in gaseous effluents : Part 1 General requirements	IS 12761 (Part 1) : 1989 Equipment for continuously monitoring radioactivity in gaseous effluents: Part 1 General requirements	Identical

Only the English language text of the International Standard has been retained while adopting it in this Indian Standard.

As in the Original Standard, this Page is Intentionally Left Blank

CHAPTER I: GENERAL

1. Scope

This standard is applicable to noble gas effluent monitors intended to fulfil the following functions:

- the measurement of the concentration of radioactive noble gases in the gaseous effluents at the discharge point and its variation with time;
- the actuation of an alarm when a predetermined concentration of noble gases in the gaseous effluent is exceeded.

The monitor may also be used for the determination of the total noble gas activity discharge over a given period and/or give information on the composition of a mixture of different gases in the discharge.

2. Object

The object of this standard is to lay down specific standard requirements, including technical characteristics, and general test conditions and to give examples of acceptable methods for noble gas effluent monitors as defined in Clause 3.

The general requirements, technical characteristics, test procedures, radiation characteristics, electrical, mechanical, safety and environmental characteristics are given in IEC Publication 761-1: Equipment for Continuously Monitoring Radioactivity in Gaseous Effluents, Part 1: General Requirements. They apply, unless otherwise stated, to this part of the standard.

3. Terminology

For the purpose of this standard, the following additional definition shall apply.

3.1 *Noble gas effluent monitor*

Equipment designed for the continuous monitoring of noble gases in gaseous effluents discharged into the environment.

4. Classification of noble gas effluent monitors

The equipment may be classified according to the type of radiation detected as:

- gross gamma activity monitors;
- gross beta activity monitors;
- specific nuclide monitors.

It may also be classified according to the method of operation:

- direct measurement with a detector in or adjacent to the effluent;
- continuous fractional sampling to a monitoring point at a remote location.

CHAPTER II: NOBLE GAS EFFLUENT MONITOR DESIGN

5. Overall equipment design

As discussed in I E C Publication 761-1, various monitor configurations are possible, depending on the exact circumstances and requirements for each installation. Irrespective of these variations, the equipment shall conform to the requirements of this standard as well as those of Chapter II of I E C Publication 761-1.

5.1 *Direct measuring equipment*

If the measurement is made directly by detectors in or adjacent to the effluent stream, only the detector and the minimum necessary electronic assembly shall be designed to operate in the appropriate plant environmental conditions and, unless there are special circumstances, this type of equipment shall not incorporate detectors which are particularly sensitive to variations in environmental conditions or require frequent attention or adjustment.

The appropriate control and measurement assembly shall be mounted, wherever practicable, in a controlled environment, so as to minimize the effect on performance and allow ready access for operation and maintenance.

5.2 *Indirect measuring equipment*

If samples of the effluent are taken to a remote location, the sampling and detection assembly (with the exception of the sampling probe and pipework) and the control and measurement assembly should be adjacent in a controlled environment. Where this is not practicable (for example, because of the excessive length of the sampling pipework involved) the same restrictions as for a detection assembly (as discussed in Sub-clause 5.1) shall be applied.

6. Expression of measurements

In accordance with the requirements of Clause 10 of I E C Publication 761-1, the electronic sub-assembly associated with the detector shall provide a reading expressed directly in the electrical unit measured, for example in counts per second or in amperes.

In addition, by agreement between manufacturer and user, the assembly may also be calibrated in terms of activity, for example becquerels per cubic metre. Depending on the type of detector employed, such calibration may require knowledge of the radionuclides involved and their relative concentrations, the detection efficiency for each nuclide and the volume of any sample and sample fraction.

Measurements of quantities of particular nuclides will probably involve a form of gamma spectrometer with the need to establish "in peak" counting efficiencies in terms of counting rate (s^{-1}) per unit activity (Bq) for specific peak widths together with the degree of interference from other gamma energy sources.

Measurements of activity released in such units as Bq-MeV may be relatively simply obtained with, for example, an ionization chamber detector mounted in the exhaust stack.

If readings are to be provided in derived units, the manufacturer and user shall be confident that all the relevant factors are understood and are either constant or corrected automatically (refer to Clause 10 of IEC Publication 761-1).

7. Sampling and detection assembly

7.1 *Sampling and exhaust pipes*

In addition to the general requirements of IEC Publication 761-1, the following characteristics shall be considered and shall be agreed between manufacturer and user;

- the nature of material used, giving particular attention to electrostatic effects and chemical corrosion;
- state of internal surface: ease of decontamination;
- delay time to detector (flow rate, pipe diameter, etc.).

7.2 *Inlet filter*

When appropriate, a filter may be placed in a filter holder at the sampling circuit inlet to remove any dust, aerosols, or iodines from the air (or gas). In order to maintain the specified performance of the assembly such a filter shall not, as far as is practicable, trap or even temporarily retain noble gases.

7.3 *Sample cell*

Where, as part of a sampling and detection sub-assembly, a measuring cell or gas chamber is used to provide a volume of gas for measurement with an immersed or adjacent detector, the following requirements shall apply:

7.3.1 The sample cell shall be of the flow-through type. It may be with or without an absorbing medium, or pressurizing facility.

7.3.2 The sample cell volume and operating pressure shall be specified.

7.3.3 Whenever practicable, the detector shall be separated from the gas or air being measured by a protective window or screen.

7.3.4 Whenever practicable, the detector shall be readily removable from the chamber for service or replacement. The detector mounting feature shall be such as to ensure that in all cases the detector can be returned to and will remain in the appropriate geometrical location. Alternative detector positions, or some other means, shall be provided to vary the response by at least a factor of 10.

7.3.5 If, in order to increase the gas monitor response to a given concentration of radioactive gas, an absorbing medium is used, the type of absorbent and its characteristics for different gases of interest shall be given.

7.4 *Radiation detector*

Any type of detector appropriate to the desired measurement may be used by agreement between manufacturer and user. The manufacturer shall specify the detector type and all relevant characteristics, particularly the response in the operating geometry to gaseous activities to be measured and to interfering activities of interest.

7.4.1 *Beta detectors*

Irrespective of the type of detector used, the manufacturer shall specify the detector dimensions and the dimensions and transmission characteristics, for example effective area, thickness, etc., of any protective screen. He shall also specify the variation of detection efficiency with beta energy.

7.4.2 *Gamma detectors*

Irrespective of the type of detector used, the manufacturer shall specify the detector response as a function of gamma energy and, in the case of detectors intended for spectrometry, the detector resolution as a function of energy.

8. Test facilities

The sample cell shall be designed so that check sources can be easily placed at defined positions near the detector.

Where the detector is mounted remote from the control and measurement assembly, there shall be provision for remotely exposing check sources.

Any check source when not in use, shall not increase the reading of the measurement assembly by more than 10% of the maximum value of the lowest useful decade of measurement.

9. Range of measurement

The effective range of measurement shall be agreed between manufacturer and user and shall be at least three decades (five or more decades may be required).

CHAPTER III: TEST PROCEDURES

Except where otherwise specified, tests are to be considered as type tests, although any or all may be considered as acceptance tests by agreement between manufacturer and user.

10. Standard test conditions

The standard test conditions are shown in Table I. These represent the values and tolerances of the various influence quantities for tests carried out with no variation of these values.

The tests performed under standard test conditions are listed in Table II.

11. Tests performed with variation of the influence quantities

These tests are listed in Tables III and IV; they shall be carried out in accordance with Clause 24 of IEC Publication 761-1.

12. Reference sources

Radioactive reference sources for gaseous effluent monitors may be of two types. Gaseous (primary) sources will normally be required for basic calibration. Other (secondary) sources may be used in addition, for routine tests or subsequent check testing. The response of assemblies to secondary sources shall generally be established by cross calibration against gaseous sources. Examples of suitable sources are given in Table V. In order to cover the range of the equipment, a number of sources are likely to be necessary, the activity of which shall be chosen in accordance with the requirements of Sub-clause 26.2.2 of IEC Publication 761-1. The conventionally true activity of the sources shall be known with an accuracy better than 10%:

$$\varepsilon_{sa} \leqslant 10\% \quad \varepsilon_{sr} \leqslant 5\%$$

12.1 *Primary sources*

Gaseous reference sources may consist of bottles of pressurized air or gas containing the noble gas with which the assembly is to be tested. These may be the gas for which the assembly is designed or some interfering gas of interest.

In order to minimize the effects of possible contamination of the gas circuits, all tests with gas sources shall proceed from low to high values of activity concentration.

12.2 *Secondary sources*

Other reference sources may be used in lieu of gas sources for routine source tests. Such sources shall be of physical form appropriate to the assembly under test—in particular so as to allow location of the source relative to the detector to be accurately fixed and repeated whenever necessary. The nuclide used shall be appropriate to the assembly under test. In the case of specific nuclide monitors, the beta or gamma energy shall be sufficiently similar to the beta or gamma energy of the noble gas for which the equipment is designed for it to provide an effective equivalent source characteristic.

In any case, the response of assemblies to such a secondary source shall be established, during type testing, relative to the primary gaseous source. This relative source response calibration may then be used, in conjunction with secondary source tests, when these are substituted for gaseous activity tests.

13. **Radiation performance tests**

These tests are undertaken under standard test conditions and are carried out without air (or gas) flow with the exception of the test described in Sub-clause 13.1.3.

If an electronic method of compensation against natural radioactivity is included, all tests of the measuring assembly shall be performed with the compensation circuits in operation, after having been adjusted according to the instructions of the manufacturer.

13.1 *Accuracy of response to reference source*

13.1.1 *Requirement*

Under standard test conditions, with calibration controls adjusted according to the manufacturer's instructions, the relative intrinsic error shall not exceed the limits given in Table II over the whole of the effective range of measurements.

13.1.2 *Tests to be carried out*

Type tests, routine source tests, and routine electronic tests shall be carried out as defined in Sub-clause 26.2 of IEC Publication 761-1. Where secondary sources are to be used for routine tests, the response of the assembly to such sources, relative to the appropriate gaseous sources, shall be established during type testing.

13.1.3 *Tests with gaseous radioactive sources*

Depending on the design of the monitor, either

- circulate air or gas labelled with a known activity (see Appendix A) through the assembly at a constant flow rate for a sufficient time to reach measurement equilibrium and note the equilibrium readings, or
- immerse the detector in a sufficiently large volume of gas to be equivalent to the volume in the actual operating position of the detector and note the reading under equilibrium conditions.

13.1.4 *Calibration of secondary sources*

Locate the appropriate secondary source at the defined position relative to the detector (the gaseous source test conditions being unchanged, but the gaseous source absent). Establish the relative response to the secondary sources at equilibrium. For subsequent routine or operational tests, locate the secondary source at the defined position relative to the detector and apply the appropriate factor for the relative response to gaseous and other sources as established in the type test.

13.1.5 *Tests with electronic signal generator*

In order to avoid the use of several sources for the routine tests, the measuring assembly alone may be tested by injection of an appropriate electronic signal at the normal detector input.

13.1.6 *Evaluation of the results*

The results shall be evaluated as prescribed in Sub-clause 26.2.5 of IEC Publication 761-1.

13.2 *Response to other radioactive gases (non-specific nuclide monitors)*

13.2.1 *Requirements*

The response of the assembly to radioactive gases other than the reference radioactive source shall be specified by the manufacturer. The range of gases of interest shall be agreed between manufacturer and user and a representative selection of these chosen for the tests. The performance of the assembly shall be shown to meet the specification.

13.2.2 *Test method*

The test method is identical to that described in Sub-clause 13.1.3, using the appropriate radioactive gas or gases. The specific activity of the gas shall be sufficient to give an indication which demonstrates that the equipment conforms with the requirements.

13.3 *Response to other radioactive gases (specific nuclide monitors)*

13.3.1 *Requirements*

The response of the assembly to radioactive gases of interest shall be specified by the manufacturer, but shall generally be less than 1% of the response to the same specific activity of the gas for which the assembly is designed. The specific activity of the gas shall be sufficient to give an indication which demonstrates that the equipment conforms with the requirements.

13.3.2 *Test method*

The test method is identical with that described in Sub-clause 13.1.3, using the appropriate radioactive gas or gases.

13.4 *Response time*

13.4.1 *Requirement*

The manufacturer shall specify the response time of the assembly which, by agreement between manufacturer and user, shall be appropriate to the particular application.

13.4.2 *Test method — Sampling or remote detection assemblies*

For this test, a recorder shall be connected to the assembly to determine the change in indications as a function of time.

The input of the air circuit of the equipment shall be connected to a two-way valve, in which one branch enables air to circulate through the circuit, while the other is connected to a tank having a volume equal to at least ten times the volume of the pipe system and the measuring chamber of the assembly under test. The tank itself shall be connected to a gas cylinder via a pressure-reducing valve and a regulating valve. The relation of the tank pressure to atmospheric pressure shall be measured. The gas cylinder shall contain the gaseous activity for which the assembly is designed. The regulating valve and the pressure-reducing valve shall be set to the rated gas flow. The tank shall be filled with the gas from the cylinder at atmospheric pressure.

At the start of the test the two-way valve shall be switched to the tank and the cylinder valve opened. The regulating valve shall be adjusted so as to maintain atmospheric pressure in the tank until the recorder reading of the assembly has reached a constant value R_F. The interval of time separating the initial moment when the reading is R_I and the moment at which the reading reaches $0.90\ (R_F - R_I) + R_I$ is the response time.

Where the test equipment neither absorbs nor concentrates activity, the installation may be simplified by connecting the outlet of the air circuit direct to the tank and isolating the cylinder from the tank at the initial moment of the test.

13.4.3 *Test method — Direct measurement assemblies*

This test shall be performed with a secondary source.

A recorder shall be operated without the test source present and the equilibrium reading R noted. The source shall then be rapidly introduced into the defined position relative to the detector and the output of the assembly recorded until a new equilibrium reading R_F is obtained. In the context of this test, "rapidly" is defined as a much shorter time than the response time being tested. The interval of time separating the moment at which the source is introduced and the moment at which the reading reaches $0.90\ (R_F - R_I) + R_I$ is the response time.

14 Tests of the air circuit

The tests specified in Clause 29 of I E C Publication 761-1 shall be carried out as appropriate.

CHAPTER IV: DOCUMENTATION

15. Certificate and type test report

With each equipment, the manufacturer shall provide a certificate giving the following information in addition to that specified in Chapter IV of IEC Publication 761-1:

- noble gas or gases for which the assembly is designed;
- detector type and general characteristics;
- response as a function of the activity per unit of volume;
- response to the check source (if supplied);
- response to the other radioactive noble gases (if the measurement is specific to a particular nuclide).

TABLE I

Reference conditions and standard test conditions

(Unless otherwise indicated by the manufacturer)

Influence quantity	Reference conditions	Standard test conditions
Reference radioactive source	Air or gas labelled with the appropriate form of noble gas	Air or gas labelled with appropriate form of noble gas
Warm-up time — electronic devices — air or gas circuit	 15 min 60 min	 ≥15 min ≥60 min
Ambient temperature	20 °C	18 °C to 22 °C
Relative humidity	65%	50% to 75%
Atmospheric pressure	101.3 kPa	86 kPa to 106 kPa*
Power supply voltage	Nominal supply voltage U_N	U_N ± 1%
Power supply frequency	Nominal frequency	Nominal frequency ±0.5%
Power supply waveform	Sinusoidal	Sinusoidal with a total harmonic distortion less than 5%
Gamma radiation background	Absorbed dose rate in air of 0.20 μGy.h^{-1} (20 μrad.h^{-1})	Less than absorbed dose rate in air of 0.25 μGy.h^{-1} (25 μrad.h^{-1})
Electromagnetic field of external origin	Negligible	Less than the lowest value that causes interference
Magnetic induction of external origin	Negligible	Less than twice the value of the induction due to the earth's magnetic field
Sampling rate	Adjusted to nominal flow rate (defined by manufacturer)	Adjusted to nominal rate ±5%
Assembly controls	Set for normal operation	Set for normal operation
Contamination by radioactive elements	Negligible	Negligible

* Where the detection technique is particularly sensitive to variation in atmospheric pressure, the conditions shall be limited to ±5% of the reference pressure.

TABLE II

Tests performed under standard test conditions

Characteristics under test	Requirements	Reference (sub-clause)	
		IEC Publ. 761-1	IEC Publ. 761-3
Reference response	In accordance with the manufacturer's specifications	26.1	
Accuracy of indication (E_I)	Less than ±20% or, for assemblies with linear scales, less than 5% of the activity corresponding to maximum indication on appropriate scale (whichever is least restrictive)	26.2	
Overload	To remain at full scale indication when exposed to an activity ten times that which would give full scale deflection	26.5	
Statistical fluctuations	Coefficient of variation less than 10%	27.1	
Stability of indication	Less than 10% of the full scale angular deflection over a period of 500 h on all ranges or less than 10% of indication for digital display	27.6	
Alarm trip stability	Less than 20% of set-point level over a period of 500 h	27.7	
Alarm trip range	In accordance with Clause 13 of IEC Publication 761-1	27.8	
Equipment failure alarms	Low level alarm in accordance with Clause 13 of IEC Publication 761-1, other alarms by agreement between manufacturer and user	27.9	

TABLE III

Test performed with variation of influence quantities

Influence quantity	Range of values of influence quantity	Limits of variation of indication	Reference (sub-clause)	
			IEC Publ. 761-1	IEC Publ. 761-3
Other radioactive gases in air or gas to be measured (non-selective monitor)	As for the noble gas or gases for which the equipment is designed	In accordance with manufacturer's specifications		13.2
Other radioactive gases in air or gas to be measured (selective monitor)	As for the noble gas or gases for which the equipment is designed	In accordance with manufacturer's specifications but normally less than 1% of the reading due to the same specific activity of the gas for which the assembly is designed		13.3
External gamma radiation from a ^{137}Cs source in defined source/detector geometry	Absorbed dose rate in air of 10 μGy.h^{-1} (1 mrad.h^{-1})	In accordance with the manufacturer's specification	26.4	
External gamma radiation from ^{137}Cs source in other geometries	Absorbed dose rate in air of 10 μGy.h^{-1} (1 mrad.h^{-1})	As specified, but normally less than twice that under reference conditions	26.4	
External gamma radiation from other sources in the defined source/detector geometry	Absorbed dose rate in air of 10 μGy.h^{-1} (1 mrad.h^{-1})	As specified but normally less than twice that under reference conditions	26.4	
Warm-up time	≤30 min	±10%1)	27.2	
Power supply voltage	88% U_N to 110% U_N (U_N = nominal supply voltage)	±10%1)	27.4	
Power supply frequency	47 Hz to 51 Hz2)	±10%1)	27.4	
Power supply transient effects	In accordance with Sub-clause 27.5 IEC Publication 761-1	In accordance with Sub-clause 27.5 of IEC Publication 761-1	27.5	
Ambient temperature3)	Indoor use: 10 °C to 50 °C Outdoor use: −10 °C to 40 °C −25 °C to 50 °C	 ±10%1) ±20%1) ±50%1)	28.1	

(Table and notes continued on page 35

TABLE III *(continued)*

Influence quantity	Range of values of influence quantity	Limits of variation of indication	Reference (Sub-clause)	
			IEC Publ. 761-1	IEC Publ. 761-3
Relative humidity	Up to 90% at 30 °C	± 10%[1]	28.2	
Atmospheric pressure	[4]	[4]	28.3	
Electromagnetic field of external origin	[4]	[4]		
Magnetic induction of external origin	[4]	[4]		

[1] Of the indication under standard test conditions.

[2] 57 Hz to 61 Hz for the United States of America and Canada.

[3] Assemblies intended for temperate climates. In hotter or colder climates other limits may be specified.

[4] No general specification. Range of value of influence quantity and limits of variation of indication to be specified if required.

Note. — For the assemblies having a non-linear scale, a linear instrument can be substituted for the indicating meter of the assembly to verify the performance called for by this table.

TABLE IV

Tests of air (or gas) circuit

(These tests are only applicable to assemblies whose response is dependent on flow rate)

Influence quantity	Range of variation	Limit of variation of nominal flow rate	Reference (Sub-clause)
			IEC Publ. 761-1
Time	1 h to 100 h	± 10%	29.1
Filter pressure drop	In accordance with the manufacturer's specifications	− 10%	29.2
Power supply voltage	From 88% U_N to 110% U_N	± 5%	29.3
Power supply frequency	From 47 Hz to 51 Hz From 57 Hz to 61 Hz for the United States of America and Canada	± 10%	29.4

TABLE V

Reference sources

Gas sources	Solid sources	Beta energy (MeV)	Gamma energy (MeV)	Half-life
^{85}Kr		0.67 (90)		10.6 years
	^{185}W	0.43 (100)	—	73 days
	^{204}Tl	0.77 (98)	—	3.9 years
^{133}Xe		0.346 (100)	0.081 (35)	5.3 days
	^{241}Am	—	0.060 (36)	458 years
	^{185}W	0.43 (100)	—	73 days
^{135}Xe		0.92 (100)	0.25 (91)	9.2 h
	^{143}Pr	0.93 (100)	—	13.8 days
	^{204}Tl	0.77 (98)	—	3.9 years
	^{203}Hg	0.21 (100)	0.279 (83)	47 days
^{41}A		1.20 (99)	1.29 (99)	110 min
	^{89}Sr	1.46 (100)	—	51 days
	^{60}Co	0.31 (100)	1.17 (100) 1.33 (100)	5.27 years
	^{137}Cs/ ^{137}Sa	0.51 (92) 1.17 (8)	0.662 (82)	30 years
	^{90}Sr/ ^{90}Y	0.54 (100) 2.25 (100)	—	28 years

Notes 1. — This table lists a number of likely gaseous (primary) and solid (secondary) reference sources in a form intended to indicate the possible solid sources for any particular gas source.

2. — Only major radiations are quoted.

3. — Figures in brackets are percentage emissions.

4. — Gaseous sources contained in ampoules may often also be used as solid sources, when the assembly under test is intended to measure gamma emissions.

APPENDIX A

PREPARATION OF NOBLE GAS REFERENCE SOURCES

Numerous techniques are available for preparation of the gaseous reference sources required for performance of the tests in this standard.

No technique is applicable unless it complies with the provisions of Clause 12.

This appendix describes two practical techniques which, if correctly performed, will enable the tests to be carried out.

A1. Use of commercially distributed cylinders of noble gas

Where such calibrated pressurized gas cylinders are commercially available, direct use may be made of these for the tests described in Sub-clauses 13.1, 13.2 and 13.3. These cylinders enable a known activity to be injected into the calibration loop, to which the equipment is connected. The test arrangement is shown in Figure A1.

Method of operation

a) Fill the known volume V between the valves A and B at a pressure above atmospheric pressure with standardized gas from the cylinder.

b) The gas volume V is then injected into the calibration loop and has a total known volume $V_1 \gg V$, where V_1 includes the volume of the equipment under test.

c) These operations are repeated until the desired activity per unit of volume is obtained in the calibration loop under atmospheric pressure.

This technique is not practicable for assemblies comprising an absorbent medium intended for the trapping or selective concentration of the gas.

A2. Use of ampoules containing noble gas

Known volumetric activity of noble gas may be obtained by breaking standard ampoules in a known volume of air or gas.

Method of operation

a) Introduce the ampoule into a suitable cylinder.

b) Close the cylinder and fill with dry air or gas to the pressure P.

c) Break the ampoule by rotating or shaking the cylinder.

If the ampoule contains a sufficient noble gas activity, the method described in Clause A1 may be applied.

Low-activity ampoules may be used to obtain directly the desired activities per unit of volume in different cylinders. Under these conditions the air or gas in each cylinder, after reduction of the pressure, is injected into the appliance under test at the rated flow rate.

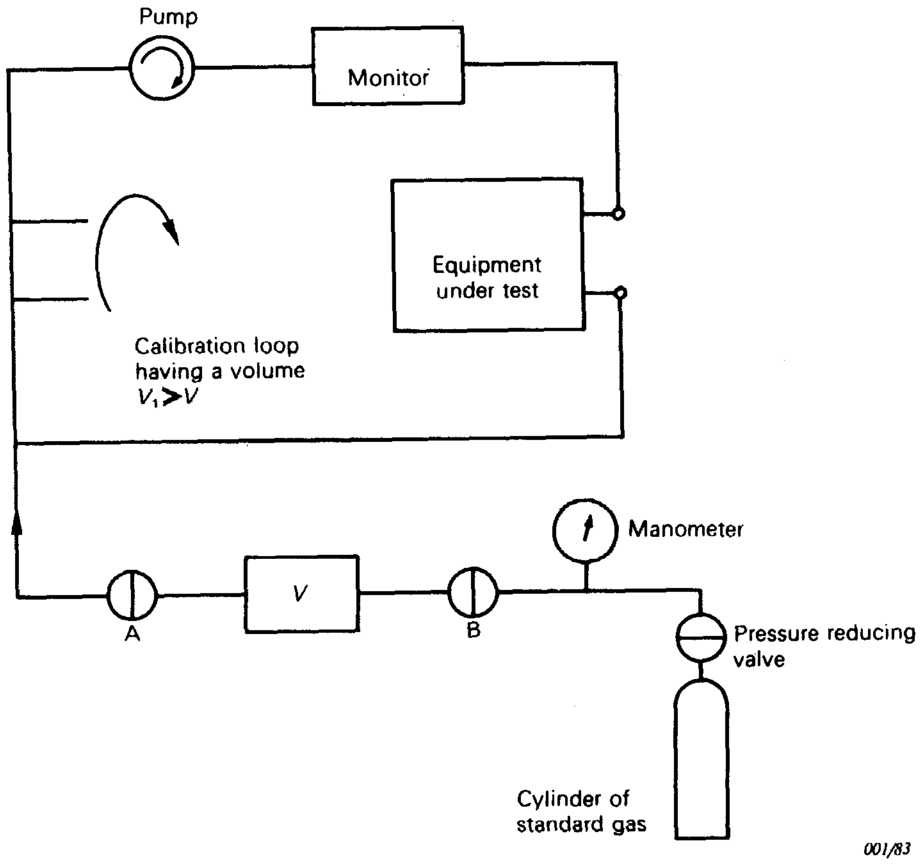

FIG. A1. — Calibration loop.

Bureau of Indian Standards

BIS is a statutory institution established under the *Bureau of Indian Standards Act, 1986* to promote harmonious development of the activities of standardization, marking and quality certification of goods and attending to connected matters in the country.

Copyright

BIS has the copyright of all its publications. No part of these publications may be reproduced in any form without the prior permission in writing of BIS. This does not preclude the free use, in the course of implementing the standard, of necessary details, such as symbols and sizes, type or grade designations. Enquiries relating to copyright be addressed to the Director (Publications), BIS.

Revision of Indian Standards

Indian Standards are reviewed periodically and revised, when necessary and amendments, if any, are issued from time to time. Users of Indian Standards should ascertain that they are in possession of the latest amendments or edition. Comments on this Indian Standard may be sent to BIS giving the following reference :

Doc : No. LTDC 26 (1354)

Amendments Issued Since Publication

Amend No.	Date of Issue	Text Affected

BUREAU OF INDIAN STANDARDS

Headquarters :

Manak Bhavan, 9 Bahadur Shah Zafar Marg, New Delhi 110002
Telephones : 331 01 31, 331 13 75

Telegrams : Manaksanstha
(Common to all Offices)

Regional Offices :	Telephone
Central : Manak Bhavan, 9 Bahadur Shah Zafar Marg NEW DELHI 110001	331 01 31 331 13 75
Eastern : 1/14 C.I.T. Scheme VII M, V.I.P. Road, Maniktola, CALCUTTA 700054	37 86 62
Northern : SCO 445-446, Sector 35-C, CHANDIGARH 160036	2 18 43
Southern : C.I.T. Campus, IV Cross Road, MADRAS 600113	41 29 16
Western : Manakalaya, E9 MIDC, Marol, Andheri (East) BOMBAY 400093	6 32 92 95

Branches : AHMADABAD. BANGALORE. BHOPAL. BHUBANESHWAR. COIMBATORE.
FARIDABAD. GHAZIABAD. GUWAHATI. HYDERABAD. JAIPUR.
KANPUR. PATNA. TRIVANDRUM.

Printed at Central Electric Press, Delhi, India